DOE/GO-102001-1165
NREL/BK-710-29267
May 2001

5.3 Water Heating

Hot water is used in Federal facilities for handwashing, showering, janitorial cleaning, cooking, dishwashing, and laundering. Facilities often have significant needs for hot water in one or more locations and many smaller needs scattered throughout the facility. Methods for reducing water-heating energy use include maintaining equipment, implementing water conservation, reducing hot water temperatures, reducing heat losses from the system, utilizing waste heat sources, and replacing equipment with higher-efficiency or renewable-energy systems.

Opportunities

Reducing the demand for hot water should be the first priority, and it can be implemented at virtually any facility through efficiency measures and by matching the water temperatures to the task. Beyond that, consider upgrading to higher-efficiency water-heating equipment or shifting to other water-heating technologies whenever equipment is being replaced or major remodeling is planned. Rooftop solar water-heating equipment should be considered—especially at the time of reroofing. Heat-recovery water heating can be considered when modifying plumbing, HVAC, power-generation, or industrial-process systems that generate waste heat. Plan ahead and select a technology for use in the event that existing water-heating equipment fails; don't just replace-in-kind.

Technical Information

WATER HEATING TECHNOLOGIES

Solar water heating captures energy from the sun for heating water. These systems have improved significantly in recent years and make economic sense in many areas. See *Section 5.3.2 – Solar Water Heating*.

Standard electric water heaters both heat and store water in insulated storage tanks. Many older units have inadequate insulation and should be replaced or fitted with insulation jackets to improve performance.

Tankless or demand electric water heaters eliminate standby losses by heating water only as it is needed. They are usually located at the point of use and are convenient for remote areas having only occasional use; however, because of very high power consumption, they can increase electric demand charges.

Steam-fired water heaters utilize centrally produced steam for heating water. These units are popular in commercial kitchens where steam is also used for cookers. Where boilers must be kept operating during summer months to supply small amounts of steam for kitchen purposes, changing to alternative water heating can be extremely cost-effective and possibly extend the life of the boiler.

Standard gas-fired water heaters use natural gas or propane burners located beneath storage tanks. Standby losses tend to be high because internal flues are uninsulated heat-exchange surfaces. Equipment should be direct-vented or sealed-combustion to minimize the risk of combustion gas spillage into the building.

Condensing gas water heaters have higher efficiency because the latent heat of vaporization is reclaimed from the combustion gases. Flue gases are cool enough to permit venting with special PVC pipe.

Tankless or demand gas water heaters are usually installed near the point of use. These are often good options for remote sites where there is adequate gas piping, pressure, and venting. Some recent developments—including higher-efficiency models with precise controllability and potential for ganging multiple units together for whole-building, staged use—are extending the practical applications for demand gas water heaters.

Direct-fire water heaters are gas-fired, demand water heaters for users of large quantities of potable water—up to several hundred gallons per minute. Using technology in existence since 1908, they mix the heat of combustion (not flame) directly with incoming water, achieving in excess of 98% efficiency while eliminating standby losses. Though expensive, these systems (produced by several manufacturers) can be very cost-effective for facilities using large quantities of hot water.

Air-source heat pump water heaters are specialized vapor-compression machines that transfer heat from the air into domestic water. Commercial kitchens and laundries are excellent opportunities because both indoor air temperatures and hot water needs are high. In the process of capturing heat, the air is both cooled and dehumidified, making space conditions more comfortable. Air-source heat pumps are recommended only if the air source is warmed by waste heat.

Ground-source and water-source heat pump water heaters are dedicated heat pumps that heat domestic water from energy captured from a water source. The heat source may be groundwater that is used for its stable year-round temperature, or a low-grade waste heat source. Ground-source heat pumps circulate the water through buried heat exchanger tubing.

Source: Direct Fire Technical, Inc.

Though requiring a high first-cost investment, a direct-fire water heater is so energy-efficient that its payback period can be short.

Desuperheaters are connected to air-conditioners, heat pumps, or refrigeration compressors. Hot refrigerant gas from the compressor is routed to the gas side of the unit's heat exchanger. Water is essentially heated for free whenever the air-conditioner, heat pump, or refrigerator compressor is operating. When a desuperheater is connected to a heat pump operating in *heating* mode, some of the heat pump's capacity is devoted to water heating.

Drainline heat exchangers are very simple, passive copper coils wrapped around wastewater drain lines. The cold-water line leading to the water heater passes through this coil, and water is preheated by hot water going down the drain. These low-cost systems are cost-effective in residential buildings (typically mounted to capture waste heat from showers). They can also work well in commercial buildings with significant hot water use.

IMPROVING WATER HEATER PERFORMANCE AND SAVING ENERGY

Insulate tanks and hot-water lines that are warm to the touch. Only recently have manufacturers installed adequate amounts of insulation on water heater tanks. Hot-water lines should be continuously insulated from the heater to the end use. Cold-water lines also should be insulated near the tank to minimize convective losses (and everywhere if high humidity is likely to cause condensation).

Limit operating hours of circulating pumps. Large facilities often circulate domestic hot water to speed its delivery upon demand. By turning off those pumps when facilities are not being used (nights and weekends, for example), both the cost of operating the pump and heat losses through pipe walls will be reduced.

Install heat traps. Heat traps are plumbing fittings that block convective heat losses from water storage tanks.

Install water heaters near the points of most *frequent* use to minimize heat losses in hot water pipes. Note, this location will not necessarily be where the most hot water is used.

Eliminate leaks. Delays in repairing dripping faucets not only waste water and energy but often lead to more expensive repairs because of valve stem and valve seat corrosion.

Repair hidden waste from failed shower diverter valves that cause a portion of the water to be dumped at a user's feet. This leakage is usually not reported to maintenance teams.

Reduce hot water temperature. Temperatures can be safely reduced to 140°F (60°C) for cleaning and laundering.

Install quality low-flow fixtures. Good-quality low-flow showerheads and faucets provide performance almost indistinguishable from that of older fixtures; avoid inexpensive models or pressure-reducing inserts that provide unsatisfactory shower performance.

Setting the water temperature too low can cause problems. Reducing the hot water set-point below 120°F (49°C) to save energy may allow *Legionella* bacteria to grow inside domestic hot water tanks.

Contacts

The FEMP Help Desk at (800) DOE-EREC (363-3732) can provide many publications about energy-efficient water heating.